

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of the claims in the above-captioned patent application.

Listing of Claims:

1. (Canceled)
2. (Currently Amended) A The solid state image pickup device according to claim 1 comprising:

a semiconductor substrate having a first layer of a first conductivity type;
a second layer of a second conductivity type opposite to the first conductivity type, said second layer being formed on the first layer, in said semiconductor substrate;

a first region of the first conductivity type formed in said second layer and constituting a photodiode with said second layer, the first region being electrically floating and capable of storing charge carriers;

a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being isolated from said first region;

a second region of the first conductivity type formed in said second layer adjacent to said first gate structure on a side opposite to said first region, and constituting a non-volatile memory element with said first region and said first gate structure;

a first wiring connected to said second region for applying a voltage to said second region;

a light shielding film formed above said first gate structure and having an aperture above said first region ; and

a control circuit for applying a first write voltage to the control gate of said first gate structure, the first write voltage being a write voltage for tunneling and injecting charges accumulated in said first region into the charge storage region,

wherein said control circuit applies a second write voltage to the control gate of said first gate structure and to the second region after the first write voltage is applied, the second write voltage being a write voltage for injecting charges accumulated in said first region into the charge storage region as hot carrier injection.

3. (Currently Amended) A ~~The~~ solid state image pickup device according to claim 1, further comprising:

a semiconductor substrate having a first layer of a first conductivity type;
a second layer of a second conductivity type opposite to the first conductivity type, said second layer being formed on the first layer, in said semiconductor substrate;

a first region of the first conductivity type formed in said second layer and constituting a photodiode with said second layer, the first region being electrically floating and capable of storing charge carriers;

a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being isolated from said first region;

a second gate structured of an insulated gate type formed adjacent to another portion of said first region; and

a second region of the first conductivity type formed in said second layer adjacent to said first gate structure on a side opposite to said first region, and constituting a non-volatile memory element with said first region and said first gate structure;

a third region of the first conductivity type formed adjacent to a side of said second gate structure opposite to said first region, said third region constituting an insulated gate type transistor with said first region and said second gate structure;

a first wiring connected to said second region for applying a voltage to said second region;

a light shielding film formed above said first gate structure and having an aperture above said first region; and

a control circuit for applying a first write voltage to the control gate of said first gate structure, the first write voltage being a write voltage for tunneling and injecting charges accumulated in said first region into the charge storage region.

4. (Currently Amended) A The solid state image pickup device according to claim 1, further comprising:

a semiconductor substrate having a first layer of a first conductivity type;

a second layer of a second conductivity type opposite to the first conductivity type, said second layer being formed on the first layer, in said semiconductor substrate;

a first region of the first conductivity type formed in said second layer and constituting a photodiode with said second layer, the first region being electrically floating and capable of storing charge carriers;

a first gate structure including a charge storage region and a control gate, said

first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being isolated from said first region;

a second region of the first conductivity type formed in said second layer adjacent to said first gate structure on a side opposite to said first region, and constituting a non-volatile memory element with said first region and said first gate structure;

a first wiring connected to said second region for applying a voltage to said second region;

a light shielding film formed above said first gate structure and having an aperture above said first region;

a control circuit for applying a first write voltage to the control gate of said first gate structure, the first write voltage being a write voltage for tunneling and injecting charges accumulated in said first region into the charge storage region; and

a fourth region of the first conductivity type projecting from an upper surface of said first layer into said second layer.

5. (Currently Amended) The solid state image pickup device according to claim 2 [[1]], wherein the charge storage region of the non-volatile memory element has a floating gate.

6. (Currently Amended) The solid state image pickup device according to claim 2 [[1]], wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.

7. (Previously Presented) A solid state image pickup device comprising:

a semiconductor substrate having a first layer of a first conductivity type;

a second layer of a second conductivity type opposite to the first conductivity type, said second layer being formed on the first layer, in said semiconductor substrate;

a first region of the first conductivity type formed in said second layer and constituting a photodiode with said second layer, the first region being electrically floating;

a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being isolated from said first region;

a second region of the first conductivity type constituting a non-volatile memory element with said first region and said first gate structure, formed in the second layer adjacent to said first gate structure on a side opposite to said first region ;

a first wiring connected to said second region for applying a voltage to said second region;

a light shielding film formed above said first gate structure and having an aperture above said first region ;

a second gate structure of an insulated gate type formed on the surface of said semiconductor substrate, adjacent to another portion of said first region; and

a third region of the first conductivity type formed in the second layer, adjacent to said second gate structure on a side opposite to said first region, said third region constituting an insulated gate type transistor with said first region and said second gate structure.

8. (Original) The solid state image pickup device according to claim 7, further comprising a control circuit for applying a bias voltage to said second gate structure to turn on the insulated gate type transistor and supplying current to the non-volatile memory element.

9. (Original) The solid state image pickup device according to claim 7, wherein the charge storage region of the non-volatile memory element has a floating gate.

10. (Original) The solid state image pickup device according to claim 7, wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.

11. (Previously Presented) A solid state image pickup device comprising:
a semiconductor substrate having a first layer of a first conductivity type;
a second layer of a second conductivity type opposite to the first conductivity type, said second layer being formed on the first layer, in said semiconductor substrate;
a first region of the first conductivity type formed in said second layer and constituting a photodiode with said second layer, the first region being electrically floating;

a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being electrically isolated from said first region;

a second region of the first conductivity type formed in the second layer, adjacent to said first gate structure on a side opposite to said first region, and constituting a

non-volatile memory element with said first region and said first gate structure;

a first wiring connected to said second region for applying a voltage to said second region;

a light shielding film formed above said first gate structure and having an aperture above said first region ; and

a control circuit for applying a forward bias voltage to the first layer of said semiconductor substrate to supply current to the nonvolatile memory element.

12. (Previously Presented) The solid state image pickup device according to claim 11, further comprising a projecting region of the first conductivity type projecting from an upper surface of said first layer into said second layer.

13. (Original) The solid state image pickup device according to claim 11, wherein the charge storage region of the non-volatile memory element has a floating gate.

14. (Original) The solid state image pickup device according to claim 11, wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.

15. (Previously Presented) A driving method for a solid state image pickup device, comprising the steps of:

(a) applying light to photodiodes distributed in a matrix layout and accumulating charges representative of image information, said photodiodes being formed in a second layer having a second conductivity type and being formed on a first layer of a semiconductor substrate, said first layer having a first conductivity type opposite to said second conductivity type, each of said photodiodes including a first region of said first

conductivity type formed in said second layer, the first region being electrically floating, said solid state image pickup device having a gate structure including a control gate and a charge storage region, and formed on the second layer adjacent said first region, said charge storage region being electrically isolated from said first region, a drain region of said first conductivity type formed in the second layer adjacent to the gate structure on a side opposite to said first region, a first wiring connected to said drain region, a second wiring connected to said first layer, and a light shielding film formed above said semiconductor substrate and having apertures respectively above the first regions of said photodiodes;

(b) applying a first write control voltage to said control gate for tunneling and injecting at least a portion of charges stored in said first region representative of the image information into the charge storage region as signal charges; and

(c) applying read control voltages to the drain region through said first wiring and to the control gate to detect a threshold voltage corresponding to an amount of the signal charges injected at said step (b) into the charge storage region.

16. (Previously Presented) The driving method for a solid state image pickup device according to claim 15, further comprising a step of, before said step (c):

(d) applying second write control voltages to the control gate and to the drain region through said first wiring and injecting as hot carriers at least a portion of the charges stored in the first region representative of the image information into the charge storage region as signal charges.

17. (Currently Amended) The driving method for a solid state image pickup device according to claim 15, wherein said step (c) includes a sub-step of:

(e) applying a bias voltage to an insulated gate type transistor formed adjacent to another portion of each of the first regions to turn on the transistor and supply a current to the first region.

18. (Previously Presented) The driving method for a solid state image pickup device according to claim 15, wherein said step (c) includes a sub-step of:

(f) applying a forward bias voltage to the first layer through said second wiring to supply a current to the first region.

19. (Previously Presented) The driving method for a solid state image pickup device according to claim 15, wherein said step (c) includes a sub-step of:

(g) applying a forward bias voltage, through said second wiring, to a projection region of the first conductivity type formed projecting from an upper surface of the first layer into the second layer to supply a current to the first region.

20. (Previously Presented) The driving method for a solid state image pickup device according to claim 15, further comprising a step of, before said step (a):

(h) applying a reverse bias voltage to the first layer through said second wiring to drain charges accumulated beforehand in the first regions to the first layer .

21. (Currently Amended) A The solid state image pickup device according to claim 1, further comprising:

a semiconductor substrate having a first layer of a first conductivity type;
a second layer of a second conductivity type opposite to the first conductivity
type, said second layer being formed on the first layer, in said semiconductor substrate;
a first region of the first conductivity type formed in said second layer and
constituting a photodiode with said second layer, the first region being electrically

floating and capable of storing charge carriers;

a first gate structure including a charge storage region and a control gate, said first gate structure being formed on a surface of said semiconductor substrate adjacent to a portion of said first region, and said charge storage region being isolated from said first region;

a second region of the first conductivity type formed in said second layer adjacent to said first gate structure on a side opposite to said first region, and constituting a non-volatile memory element with said first region and said first gate structure;

a first wiring connected to said second region for applying a voltage to said second region;

a light shielding film formed above said first gate structure and having an aperture above said first region;

a control circuit for applying a first write voltage to the control gate of said first gate structure, the first write voltage being a write voltage for tunneling and injecting charges accumulated in said first region into the charge storage region; and

a second wiring connected to said first layer for applying a reset voltage from a voltage source to extinguish a potential barrier in the second layer and clear charges accumulated in the first region.

22. (Currently Amended) A The solid state image pickup device according to claim 1, further comprising:

a semiconductor substrate having a first layer of a first conductivity type;

a second layer of a second conductivity type opposite to the first conductivity

type, said second layer being formed on the first layer, in said semiconductor substrate;

a first region of the first conductivity type formed in said second layer and
constituting a photodiode with said second layer, the first region being electrically
floating and capable of storing charge carriers;

a first gate structure including a charge storage region and a control gate, said
first gate structure being formed on a surface of said semiconductor substrate adjacent
to a portion of said first region, and said charge storage region being isolated from said
first region;

a second region of the first conductivity type formed in said second layer
adjacent to said first gate structure on a side opposite to said first region, and
constituting a non-volatile memory element with said first region and said first gate
structure;

a first wiring connected to said second region for applying a voltage to said
second region;

a light shielding film formed above said first gate structure and having an
aperture above said first region;

a control circuit for applying a first write voltage to the control gate of said first
gate structure, the first write voltage being a write voltage for tunneling and injecting
charges accumulated in said first region into the charge storage region; and

a fifth region of the second conductivity type, formed in a surface portion of said first region.

23. (Previously Presented) The solid state image pickup device according to claim 7, further comprising a second wiring connected to said first layer for applying a

reset voltage from a voltage source to extinguish a potential barrier in the second layer and clear charges accumulated in the first region.

24. (Previously Presented) The solid state image pickup device according to claim 7, further comprising a fifth-region of the second conductivity type, formed in a surface portion of said first region.

25. (Previously Presented) The solid state image pickup device according to claim 11, further comprising a second wiring connected to said first layer for applying a reset voltage from a voltage source to extinguish a potential barrier in the second layer and clear charges accumulated in the first region.

26. (Previously Presented) The solid state image pickup device according to claim 11, further comprising a fifth region of the second conductivity type, formed in a surface portion of said first region.

27. (New) The solid state image pickup device according to claim 3, wherein the charge storage region of the non-volatile memory element has a floating gate.

28. (New) The solid state image pickup device according to claim 3, wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.

29. (New) The solid state image pickup device according to claim 4, wherein the charge storage region of the non-volatile memory element has a floating gate.

30. (New) The solid state image pickup device according to claim 4, wherein the charge storage region of the non-volatile memory element has an interface between a silicon nitride film and a silicon oxide film.